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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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09/707,709

11/07/2000

Rohit Patnaik

99,868-A

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7590

03/16/2004

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EXAMINER

AHMED, SAMIR ANWAR

ART UNIT

PAPER NUMBER

2623

DATE MAILED: 03/16/2004

6

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/707,709

Applicant(s)

PATNAIK, ROHIT

Examiner

Samir A. Ahmed

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☐ Responsive to communication(s) filed on ____.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-20 is/are pending in the application.
- 4a) Of the above claim(s) ____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) ____ is/are allowed.
- 6) ☒ Claim(s) 1-7, 10-13 and 15-20 is/are rejected.
- 7) ☒ Claim(s) 8-9, 14 is/are objected to.
- 8) ☐ Claim(s) ____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on ____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. ____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date 5.
- 4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. ____.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: ____.

Claim Rejections - 35 USC § 102

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

2. Claims 1, 7 and 10 rejected under 35 U.S.C. 102(e) as being anticipated by Kang et al. (U.S. Patent 5,978,440).

As to claim 1, Kang discloses, an inspection method utilizing vertical slicing imaging, comprising the steps of:

acquiring data corresponding to a number of horizontal slice images, extending through an object of interest [Figs. 2 and 3, a number of horizontal cross sectional images 16 (slices) are obtained, extending through an object of interest 12 or 33, also in Fig. 12 a set of horizontal cross section images (slices) are obtained extending through focal plane at the center of the solder ball of the BGA package (object of interest shown in Fig. 13)];

defining a vertical region of interest from the data [a cross sectional image for a height plane spaced part from the focal plane of the object by h (vertical region of interest) is realized by calculating (defining) the shifted vertical distances (ls) above and below the focal plane (col. 7, line 16-col. 8, line 5), also in Fig. 13 (b) a focal plane located at the center of the solder ball at Z0 (vertical region of interest is defined); and

constructing a vertical slice image based upon data falling within the vertical region of interest [the cross sectional image at height h (vertical slice) is synthesized from the cross sectional image above and below the focal plane (col. 8, lines 8-11, Fig. 4, s71) and also the vertical slice at Z0 is synthesized from 8 horizontal images]].

As to claim 7, Kang further discloses, wherein the step of defining the vertical region of interest comprises locating a best vertical slice image [the cross sectional image at height Z0 (vertical slice) in Fig. 13 (b) shows only the balls on the focal plane located at the center of the solder ball and the balls of out-of- the focal plane were blurred (i.e., best vertical slice) (col. 9, lines 5-7)].

As to claim 10, Kang further discloses, wherein the step of acquiring data comprises:

applying penetrating radiation to the object of interest (Fig. 2, item 10 and Fig. 3, item 31); and

detecting radiation passing through the object of interest (Fig.2, item 14 and Fig. 3, item 37).

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

4. Claims 2-6, 11-20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kang et al. (U.S. Patent 5,978,440) as applied to claim 1 above, and further in view of Rooks (U.S. Patent 5,719,952).

As to claim 2, Kang discloses defining a vertical region of interest as shown above.

Kang does not disclose, wherein the step of defining the vertical region of interest comprises locating a best horizontal slice image passing through the region of interest.

Rooks discloses a method to inspect a BGA by studying cross sectional X-ray images of solder joints between electronic components using scanned beam X-ray laminography or digital tomosynthesis (Abstract). As shown in Fig. 7, three specific horizontal image slices at different vertical positions namely Ball Slice 100, Pad Slice 102, and Package Slice 104. The ball and pad centroids are determined (col. 7, line 31- col. 8, line 40). Solder thickness is measured from a histogram of pixel gray-levels generated inside a circular ROI that circumscribes both the pad and the ball (col. 8, lines 47-59) (i.e. locating the best horizontal slice based on the histogram and amount of solder). It would have been obvious to one with ordinary skill in the art at the time the invention was made to use Rooks teachings to modify the method of Kang by locating a best horizontal slice image passing through the region of interest in order to detect the solder volume and ball/pad alignment which are the most critical characteristics of BGA package to insure long term reliability and to further reduce the joints susceptibility to fatigue failure.

As to claim 3, Kang further discloses, wherein the step of constructing the vertical slice image comprises synthesizing the vertical slice image from

horizontal slice images above and below the best horizontal slice image [the cross sectional image at height h (vertical slice) is synthesized from the cross sectional image above and below the focal plane (col. 8, lines 8-11, Fig. 4, s71)].

As to claim 4, Rooks further discloses, wherein the step of locating the best horizontal slice image comprises computing, for at least two horizontal slice images, an amount of solder within each of the at least two horizontal slice images [thickness of solder is measured in the Ball Slice (col. 8, lines 27-30), the Pad and Package Slices (col. 8, line 47-col. 9, line 27)].

As to claim 5, Rooks further discloses, wherein the step of locating the best horizontal slice image further comprises reviewing a distribution of the computed amounts of solder (col. 9, line 64-col. 10, line 19).

As to claim 6, Rooks further discloses, wherein the step of locating the best horizontal slice image comprises identifying one or more anchor devices in the horizontal slice images [Pad in Pad Slice (horizontal slice image) is an anchor device].

As to claim 11, refer to claim 1 rejection for their common features. Kang further discloses that his method is used to monitor the soldering state of the solder joints in a BGA package because it has a serious effect on the product (col. 8, lines 41-45). Kang does not specifically disclose, analyzing the vertical slice image to determine whether a defect is present.

Rooks discloses a method to inspect a BGA by studying cross sectional X-ray images of solder joints between electronic components using scanned beam X-ray

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laminography or digital tomosynthesis (Abstract). As shown in Fig. 7, three specific image slices at different vertical positions namely Ball Slice 100, Pad Slice 102, and Package Slice 104 (col. 7, line 31-col. 8, line 40). The slices are analyzed for to identify defective Ball-Grid-Array joints (col. 7, lines 7-19). It would have been obvious to one with ordinary skill in the art at the time the invention was made to use Rooks teachings to modify the method of Kang by analyzing the vertical slice image in order to detect the solder volume and ball/pad alignment defects which are the most critical characteristics of BGA package to insure long term reliability and to further reduce the joints susceptibility to fatigue failure.

As to claim 12, Rooks further discloses, wherein analyzing the vertical slice image comprises determining whether a BGA joint is lifted [Ball/Pad offset (BGA joint is lifted (col. 7, line 3, col. 8, line 37-43))].

As to claim 13, Rooks further discloses, wherein determining whether the BGA joint is lifted comprises:

determining a measure of a height of the BGA joint (col. 7, lines 5-6); and
comparing the height to a threshold (col. 10, lines 32-37).

As to claim 15, Rooks further discloses, wherein analyzing the vertical slice image comprises determining whether a solder fillet is properly formed (col. 9, lines 30-60).

As to claim 16, Rooks further discloses, wherein analyzing the vertical slice image comprises determining whether a void is present [open solder condition is a void (col. 9, line 64-col. 10, line 19)].

As to claim 17, Rooks further discloses, further comprising the step of determining a size of the void when the void is present (col. 10, lines 1-15).

As to claim 18, Rooks further discloses, wherein analyzing the vertical slice image comprises determining whether a device is tilted (col. 3, line 3-col. 4, line 5).

As to claim 19, Rooks further discloses, wherein analyzing the vertical slice image comprises detecting whether a bridge is present (col. 10, lines 44-47).

As to claim 20, Rooks further discloses, wherein analyzing the vertical slice image comprises detecting whether an insufficient amount of solder is present [low solder condition (col. 9, line 64- col. 10, line 19).

Allowable Subject Matter

5. Claims 8-9, 14 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

As to claim 8, the limitation, wherein locating the best vertical slice image comprises computing, for at least two vertical slice images, an amount of solder within each of the at least two vertical slice images, is not disclosed or suggested by the prior art of record.

As to claim 14, the limitation, wherein determining whether the BGA joint is lifted comprises:

calculating a midpoint for a plurality of adjacent BGA joints; and

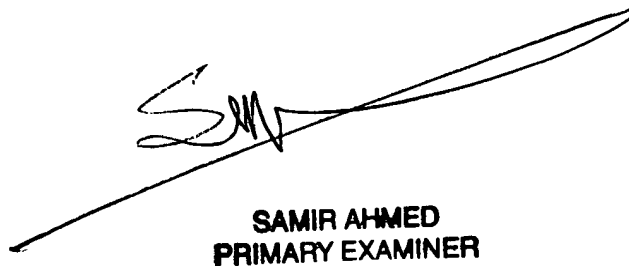
comparing at least two of the calculated midpoints to each other, is not disclosed or suggested by the prior art of record. Any inquiry concerning this communication or

earlier communications from the examiner should be directed to Samir A. Ahmed whose telephone number is 703-305-9870. The examiner can normally be reached on Mon-Fri 8:30am-6:00pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Amelia Au can be reached on 703-308-6604. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

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**SAMIR AHMED
PRIMARY EXAMINER**